Brief summary of MIPs proposals related to systematic biases

Some context…

- CMIP and related MIPs form a foundation for the study of systematic errors in climate models
  - DECK simulations well suited for identifying and documenting errors
  - Additional experimentation often needed to sufficiently diagnose root causes
  - Some proposed CMIP6-MIPs provide such targeted experimentation (or augmented data request)

Brief summary of MIPs proposals related to systematic biases

MIPs with systematic errors ranked as highest priority

- **OCMIP** Ocean Carbon Cycle MIP
- **SensMIPs** (Paramater) Sensitivity MIP
- **LS3MIP** Land Surface, Snow and Soil Moisture MIP
- **GMMIP*** Global Monsoons MIP
- **HiResMIP** High Resolution MIP

Diagnostic MIPs with systematic errors ranked as highest priority

- **CFMIP COSP**
- **DynVar**

Other MIP proposals with connections to systematic errors

OCMIP6 (Coordinator: James Orr)

To improve & accelerate development of ocean biogeochemical models (OBGCMs) via model evaluation & comparison

Plans within OCMIP6:

- Evaluate & compare coupled OBGCMs (CMIP6 DECK results)
- OGCM forced simulations with same OBGCMs (CORE forcing, 1958-2014)
- Evaluate circulation models with passive tracers, namely CFC's and SF6
- Compare intrinsic variability in coupled & forced simulations

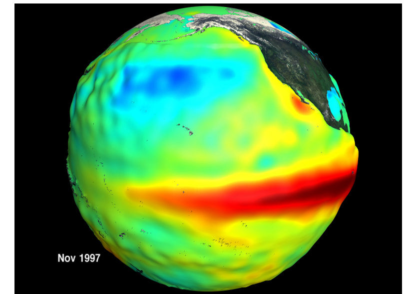
Systematic errors to be addressed:

- Subsurface ventilation (simulated vs. observed CFCs & SF6)
- Mean state & annual cycle (compare to climatologies: WOA, GLODAP, ...)
- Trends & variability
  - compare to time-series stations
  - compare coupled vs. forced OBGCM (CORE reanalysis forcing)

HighResMIP

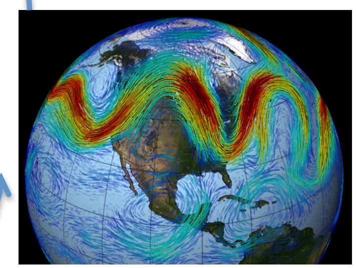
Slide courtesy of project leaders

Rein Haarsma KNMI (lead)
Malcolm Roberts Met Office (co-lead)



Global drivers

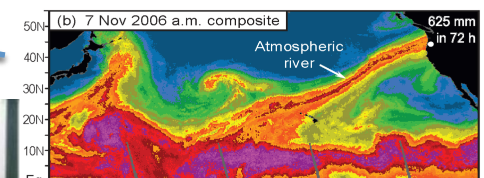
Regional variability



Feedbacks to large scale

- Important weather and climate processes emerge at sub-50km resolution
- They contribute significantly to both large-scale circulation and local impacts, hence vital for understanding and constraining regional variability
- How robust are these effects?
- Is there any convergence with resolution across models?

Need coordinated, simplified experimental design to find out



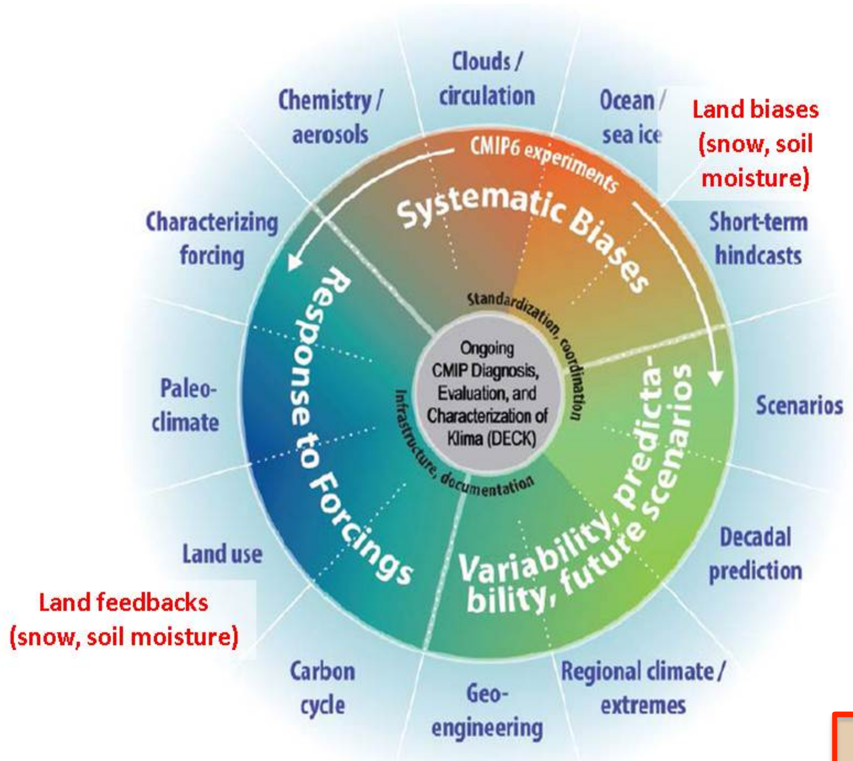
Local processes

Experimental protocol:
Global models – **AMIP-style and coupled**
Physical climate system only
Integrations: **1950-2050**
Ensemble size: >=1 (ideally 3)
Resolutions: **<25km HI and ~60-100km STD**
Aerosol concentrations specified

Impacts, extremes

e.g. Zhao et al, 2009; Haarsma et al, 2013; Demory et al, 2013

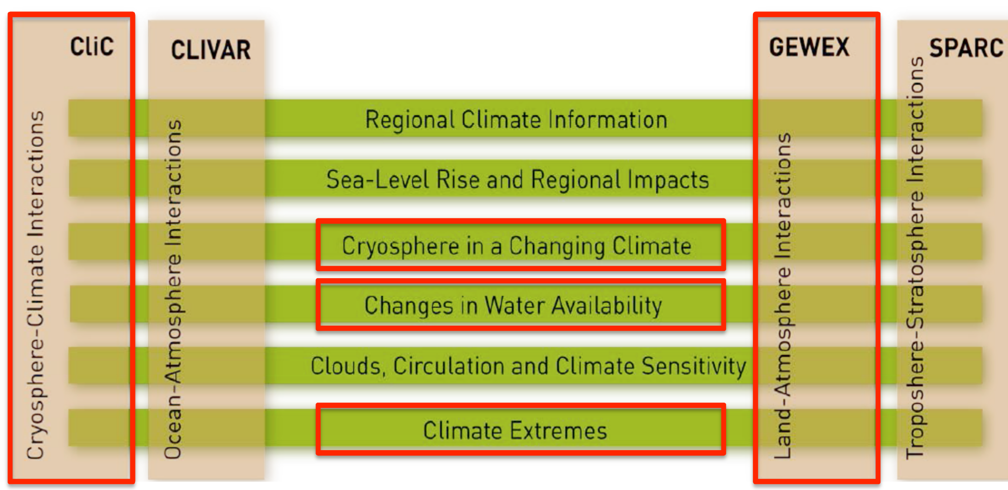
Land Surface, Snow and Soil Moisture MIP (LS3MIP)



Addresses systematic biases as well as feedbacks

Relevant for several grand challenges

LS3MIP within WCRP Core Projects and Grand Challenges



Benchmark for land surface models (DECK)

Diagnose land-atm feedback at annual and decadal time scale

Land-related predictability

Row	Name of MIP	Proposed Experiment Name	Experiment Description / Design	Science Question and/or Gap Being Addressed with this Experiment	The experimental CMIP6 design is focused on three broad scientific questions. Please rank the three science questions in order of importance for and input from your MIP for each proposed experiment (from 1-3 with 1 being most important and 0 for not relevant at all)			It is proposed to use as the scientific backdr… Challenges (GC), and an additional theme … to biospheric forcings and feedbacks. Pleas… of collaboration in order of importance for … experiment (from 1-7 with 1 being most im… all)			
5					How does the Earth System …	What are the origins and consequences of systematic model biases?	How can we assess future climate changes given climate variability, predictability	Clouds, Circulation and Climate Sensitivity	Changes in Cryosphere	Climate Extremes	Regional Climate Information
97	LS3MIP	LMIP-Hist	Land only sim[illegible]	[illegible]	[illegible]	1	3	0	2	3	4
98	LS3MIP	[illegible]	Land only simulations	Climate trend analysis	2	1	3	0	2	3	4
99	LS3MIP	LFMIP-Hist-AGCM	Prescribed land conditions 1980-2014 climate; AGCM	diagnose land-climate feedback over land	2	1	3	0	2	3	4
100	LS3MIP	LFMIP-Hist-AOGCM	Prescribed land conditions 1980-2014 climate; AGCM	diagnose land-climate feedback including ocean response	2	1	3	0	2	3	4
101	LS3MIP	LFMIP-HistRM-AGCM	Prescribed land conditions 30yr running mean; AGCM	diagnose land-climate feedback over land	2	1	3	0	2	3	4
102	LS3MIP	LFMIP-HistRM-AOGCM	Prescribed land conditions 30yr running mean; AGCM	diagnose land-climate feedback including ocean response	2	1	3	0	2	3	4
103	LS3MIP	LFMIP-Fut-AGCM	Prescribed l[illegible] climate; AO[illegible]	[illegible]	2	1	3	0	2	3	4
104	LS3MIP	LFMIP-Fut-AOGCM	Prescribed l[illegible] climate; AOGCM	[illegible] response	2	1	3	0	2	3	4
105	LS3MIP	LFMIP-FutRM-AGCM	Prescribed land conditions 30yr running mean; AOGCM	diagnose land-climate feedback over land	2	1	3	0	2	3	4
106	LS3MIP	LFMIP-FutRM-AOGCM	Prescribed land conditions 30yr running mean; AOGCM	diagnose land-climate feedback including ocean response	2	1	3	0	2	3	4
107	LS3MIP	LFMIP-P	Initialized pseude-observations land	land-related predictability	2	1	3	0	2	3	4
	LUMIP	[illegible]	Historical land only simulation with land	Assess land use change impact on historic water,	1	2	0	0	0	3	4

Tier-2 experiments devoted to specific processes (snow depth, snow albedo, land use, ...)

Sensitivity Model Intercomparison Project (SensMIP)

D. Neelin, P. Gleckler, A. Bracco

- First step to address structural and parameterization errors in same framework (i.e., MME + PPE)
- Identify degree of sensitivity/nonlinearity typically associated with key hydrological processes (spatial diagnosis rarely emphasized in PPE)
- Tier 1: AMIP experiments
- Tier 2: Experiments addressing global warming sensitivity
- Based on established framework (Neelin et al., 2010)
- Simple design focusing on interpretable parameter dependencies (3-10) parameters associated with convective processes, precipitation formulation
- Computational costs moderate while permitting adequate statistical significance at each parameter point

Global Monsoons Modeling Inter-comparison Project (GMMIP)

TASK-1: Understanding 20th century changes of global monsoons

– 4 additional historical simulations exp designs (3 coupled)

TASK-2: Interannual variability of global monsoon precipitations

– 4 new coupled experiments

TASK-3: The role of Eurasian orography on the regional/global monsoons (Himalaya/Tibetan Plateau experiment)

– 3 additional AMIP exps targeting orography sensitivity

TASK-4: High resolution modeling of global monsoons

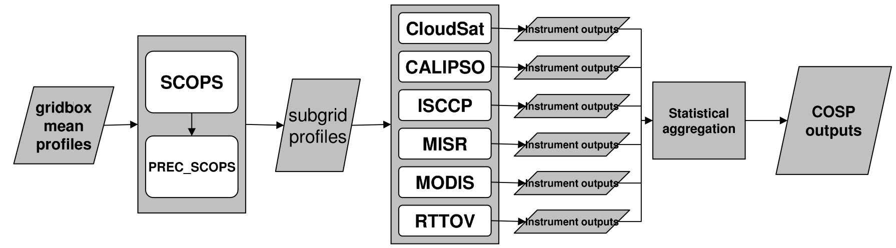
- Needs to be coordinated with HiResMIP

> 3000 years of simulation

Diagnostic MIPs

No new experiment only recommendation for changes to standard model output

CFMIP Observational Simulator Package (COSP) in CMIP6



Bodas-Salcedo et al. (BAMS 2011)

Alejandro Bodas-Salcedo and Stephen Klein
Co-chairs of the COSP Project Management Committee

http://cfmip.metoffice.com/COSP.html
https://code.google.com/p/cfmip-obs-sim/

COSP is a diagnostic code embedded into climate models that enables fairer comparison of a model's clouds to satellite observations and clouds in other models

Why is COSP essential for CMIP6?

- Consistent evaluation of model clouds with satellite observations
- Diagnosis of response of clouds to greenhouse gases (and aerosols)
- Past achievements: 20+ papers analyzing COSP output in CMIP5/CFMIP2

COSP diagnostic request from CMIP6 DECK experiments

- Expanded (longer simulation periods) yet streamlined
- Simulators for additional satellites: MODIS + MISR
- Greater number of variables: Particle sizes and Cloud phase

Why will COSP be more successful?

- COSP code is ready now (unlike in CMIP5)
- COSP has been highly optimized and is faster than the CMIP5 version

DYNVAR

Standard output requests for the DECK experiments

Include diagnostics of parameterized and resolved wave forcings, radiative and latent heating rates, better stratospheric resolution on **daily** time scale

Requesting archival of parameterized atmospheric gravity wave driving and of the Transformed Eulerian Mean (TEM) atmospheric circulation, allowing diagnosis of resolved wave driving and transport. Widely used in the analysis of the chemistry climate models (e.g. CCMVal and CCMI).

14 3D daily fields, all years for DECK exps except piControl (30yrs)

18 monthly means… non-trivial "Transformed Eulerian Mean diagnostic calculated from high frequency (6hr or shorter time intervals) in spherical, log-pressure coordinates"

DYNVAR

1	EP-divergence	$ms^{-1}d^{-1}$	Monthly mean of Transformed Eulerian Mean diagnostic calculated from high frequency (6hr or shorter time intervals) atmospheric fields; in spherical, log-pressure coordinates. Reference: Andrews et al (1987): Middle Atmospheric Dynamics. Accademic Press.
1	u-tendency by vs advection	$ms^{-1}d^{-1}$	Monthly mean of Transformed Eulerian Mean diagnostic calculated from high frequency (6hr or shorter time intervals) atmospheric fields; in spherical, log-pressure coordinates. Reference: Andrews et al (1987): Middle Atmospheric Dynamics. Accademic Press.
1	u-tendency by ws advection	$ms^{-1}d^{-1}$	Monthly mean of Transformed Eulerian Mean diagnostic calculated from high frequency (6hr or shorter time intervals) atmospheric fields; in spherical, log-pressure coordinates. Reference: Andrews et al (1987): Middle Atmospheric Dynamics. Accademic Press.
1	u-tendency by orographic gw	$ms^{-1}d^{-1}$	Monthly zonal mean of zonal tendency by orographic gravity wave parameterization
1	v-tendency by orographic gw	$ms^{-1}d^{-1}$	Monthly zonal mean of meridional tendency by orographic gravity wave parameterization
1	u-tendency by non-orographic gw	$ms^{-1}d^{-1}$	Monthly zonal mean of zonal tendecy by non-orographic gravity wave parameterization
1	v-tendency by non-orographic gw	$ms^{-1}d^{-1}$	Monthly zonal mean of meridional tendency by non-orographic gravity wave parameterization

Synthesis: Criteria for MIPs to be endorsed for CMIP6

- **Addresses at least one key science question of CMIP6 – yes for all**
- **Builds on the shared CMIP DECK experiments – yes**
- Follows CMIP standards – presumably yes
- Commitment to analyze – yes
- Timeframe – coincident with CMIP6

- **A sufficient number of modeling groups have agreed to participate in the MIP? Mixed results**

- **The proposed experiment has been run at least by two modeling groups already**

Types questions that need to be addressed (examples)

- OCMIP coordination with OMIP (not yet proposed)
- SensMIP necessary to make data widely available?
- HiResMIP *coupled* simulations (Tier 1 and Tier 2)
- GS3MIP and GMMIP complex experimental design – how many experiments to include as part of CMIP6?
- If Diagnostic MIPs are included in DECK are they mandatory?

END